

LIQUID ARGON MEASUREMENT STATUS REPORT

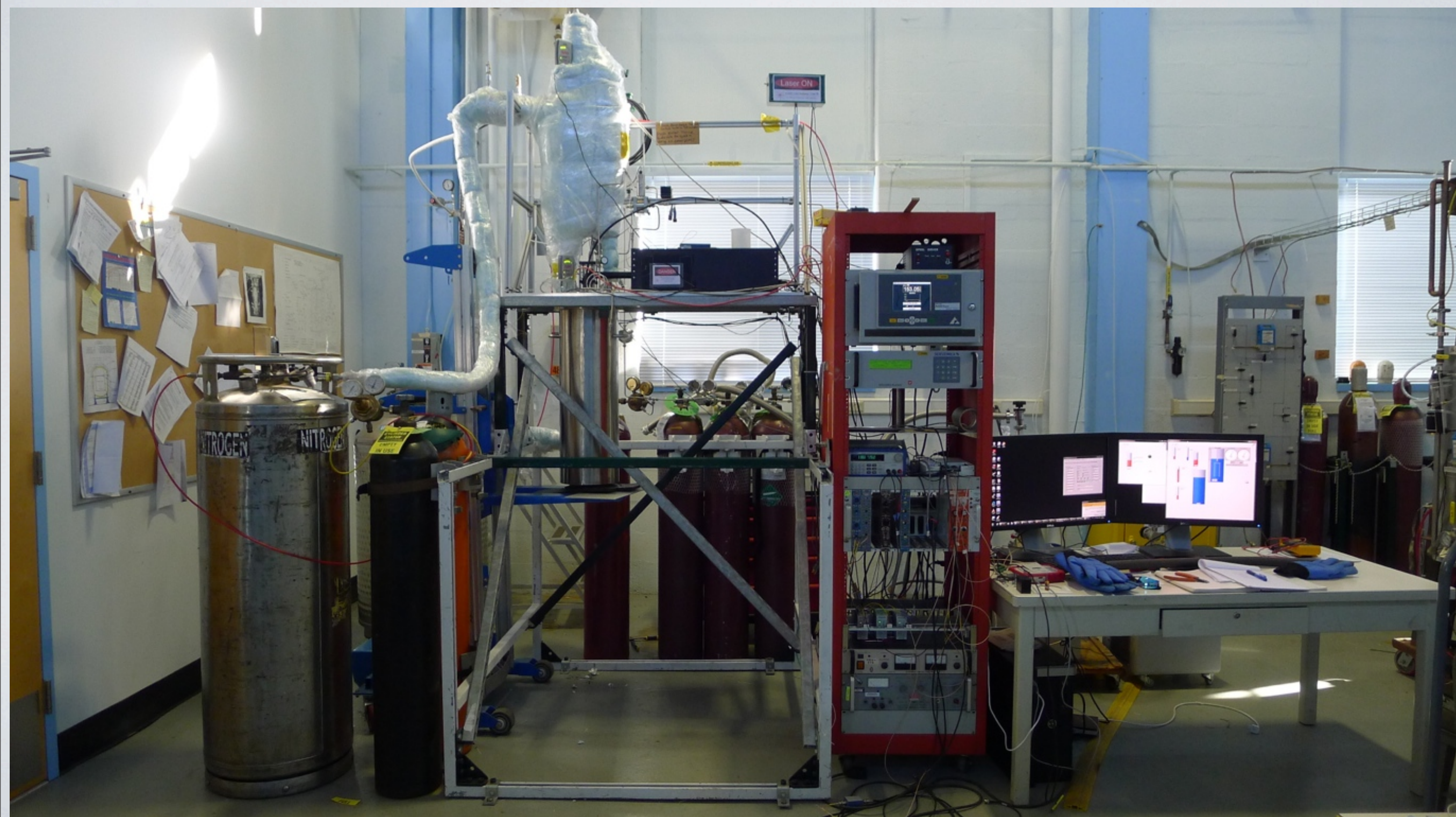
Yichen
08/20/2013

Outlines:

1. Introduction: Status
2. System Modeling and Data Analysis
3. Summary

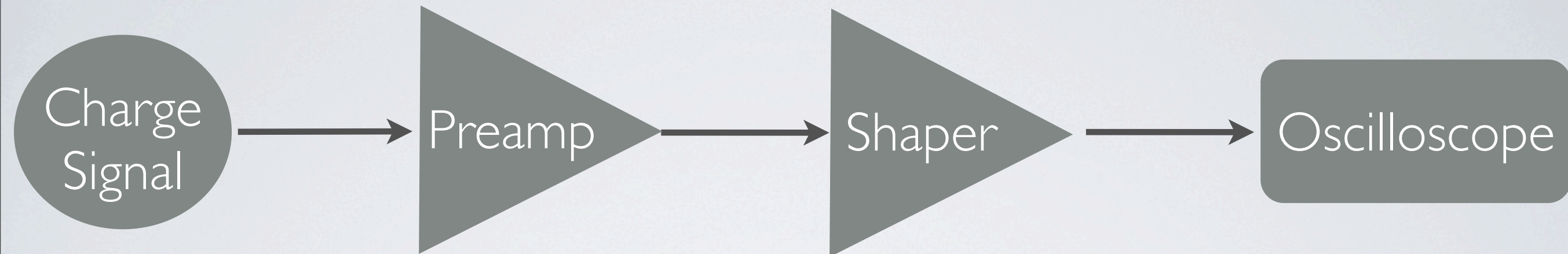
Introduction: Status

1. The system runs non-stop since 08/02.
2. LAr order has been delivered.
3. System modeling and a preliminary analysis on existing data is processed.



System Modeling: Introduction

1. In order to simulate the charge signal analysis the experimental data. A model is developed including all the components of the system.



2. The model is basically a series of convolutions processes by treating each individual module as a filter:

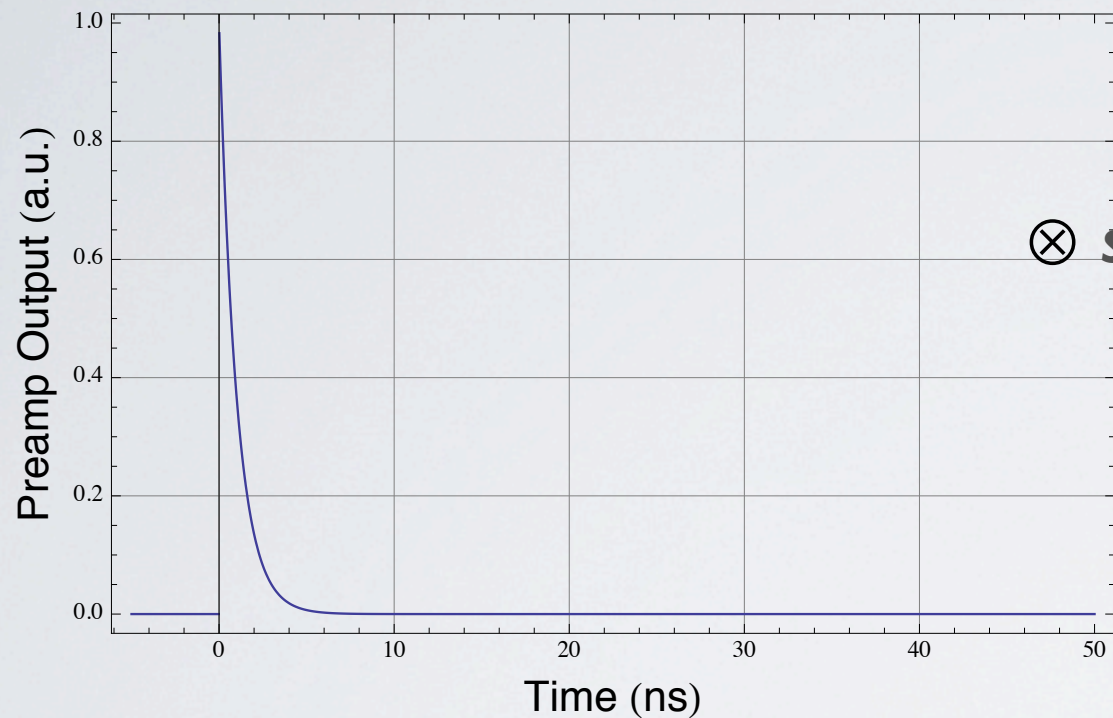
$$V_{out}(t) = V_{electron}(t) \otimes H_{preamp}(t) \otimes H_{shaper}(t)$$

$H(t)$ is the transfer function in time domain

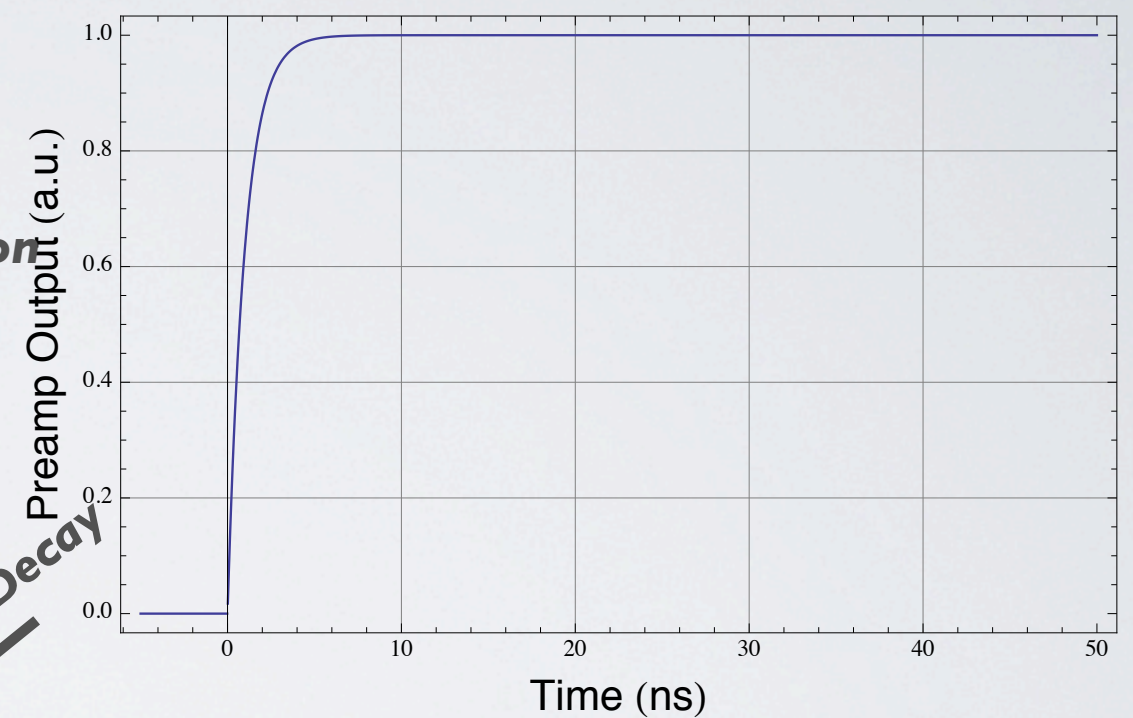
System Modeling: Preamp Modeling

1. The preamplifier response is also separated into several convolutions processes.
2. The model agrees with the preamp response to the pulser input data.

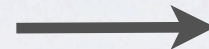
Preamp Impulse Response



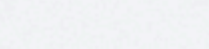
Preamp Step Response



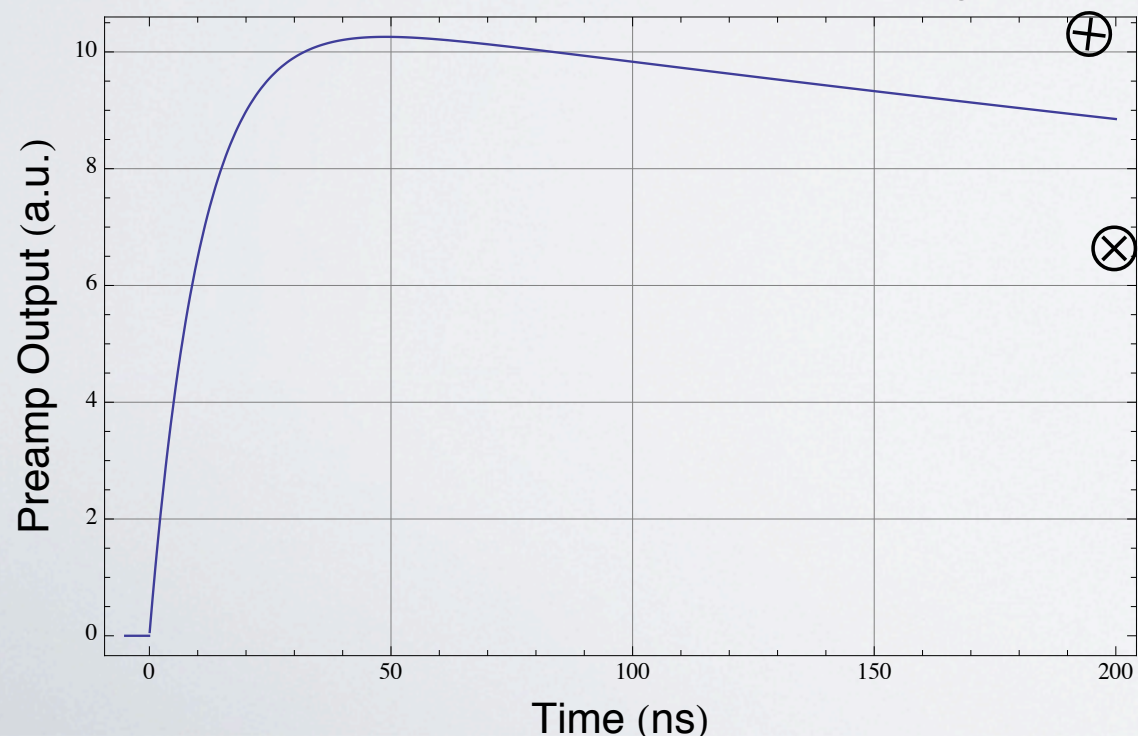
⊗ **Step function**



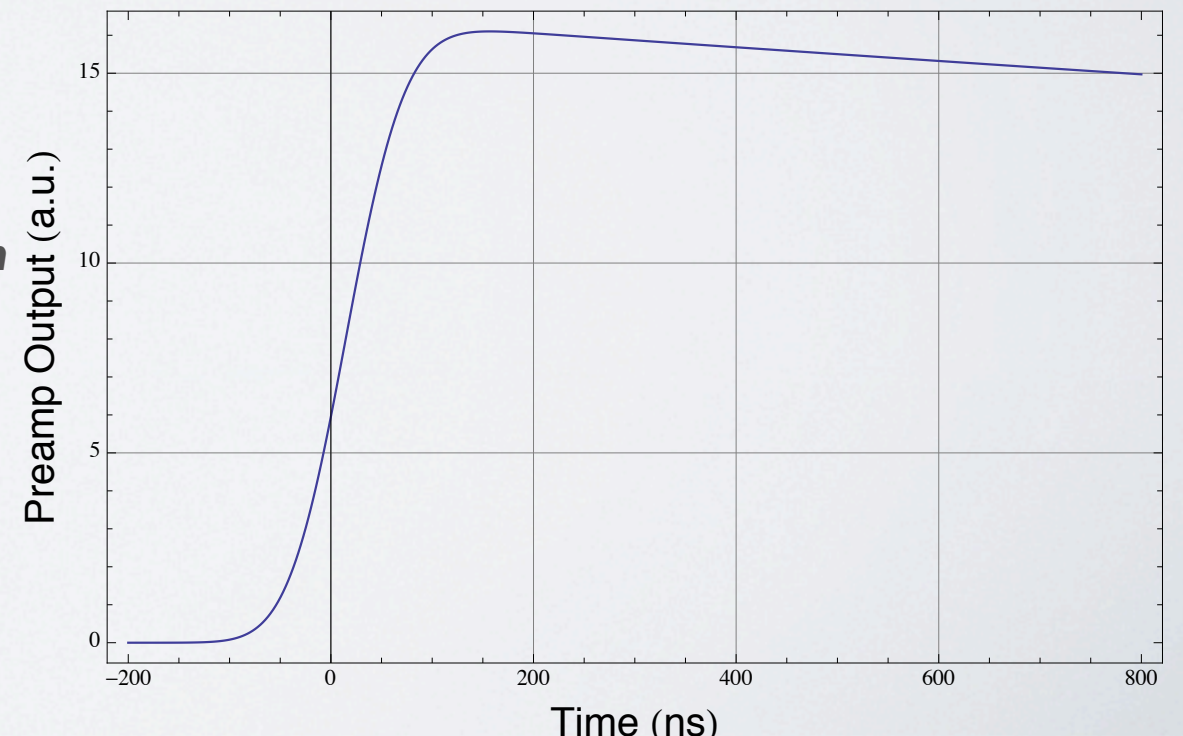
⊗ **Exponential Decay**



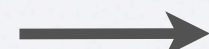
Preamp Step Response with damping



Preamp Step Response with damping and Gaussian Avg.



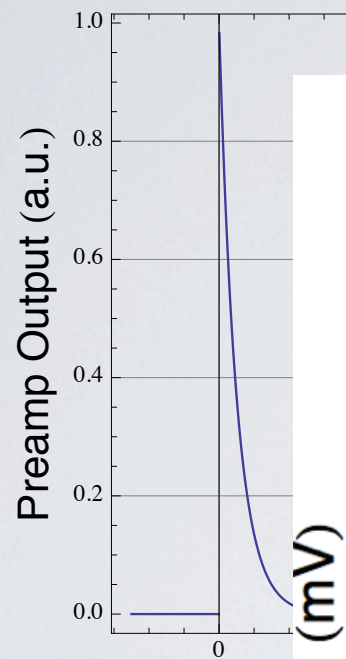
⊗ **Gaussian**



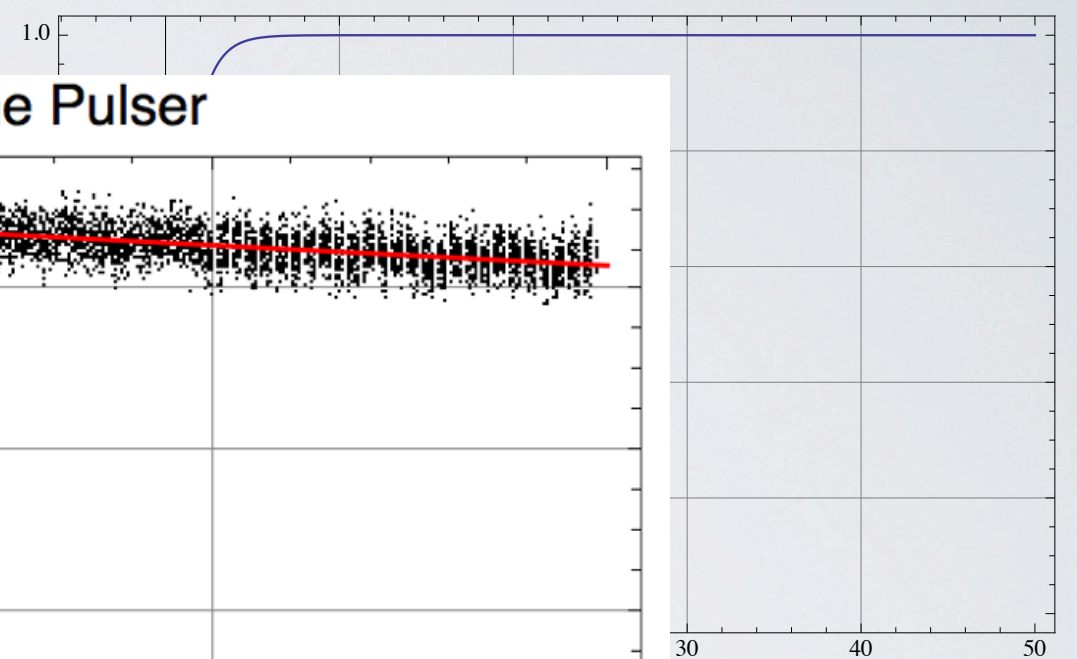
System Modeling: Preamp Modeling

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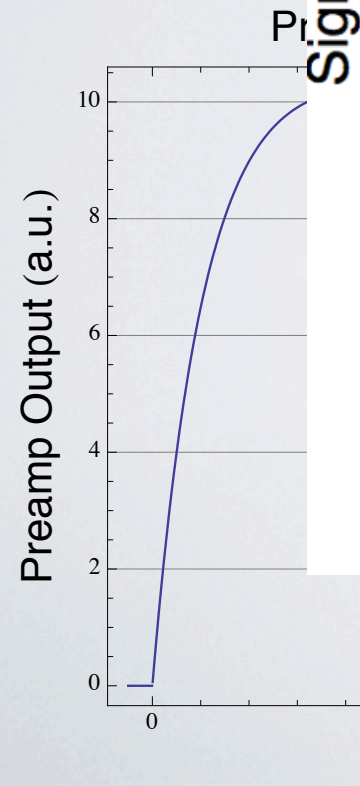
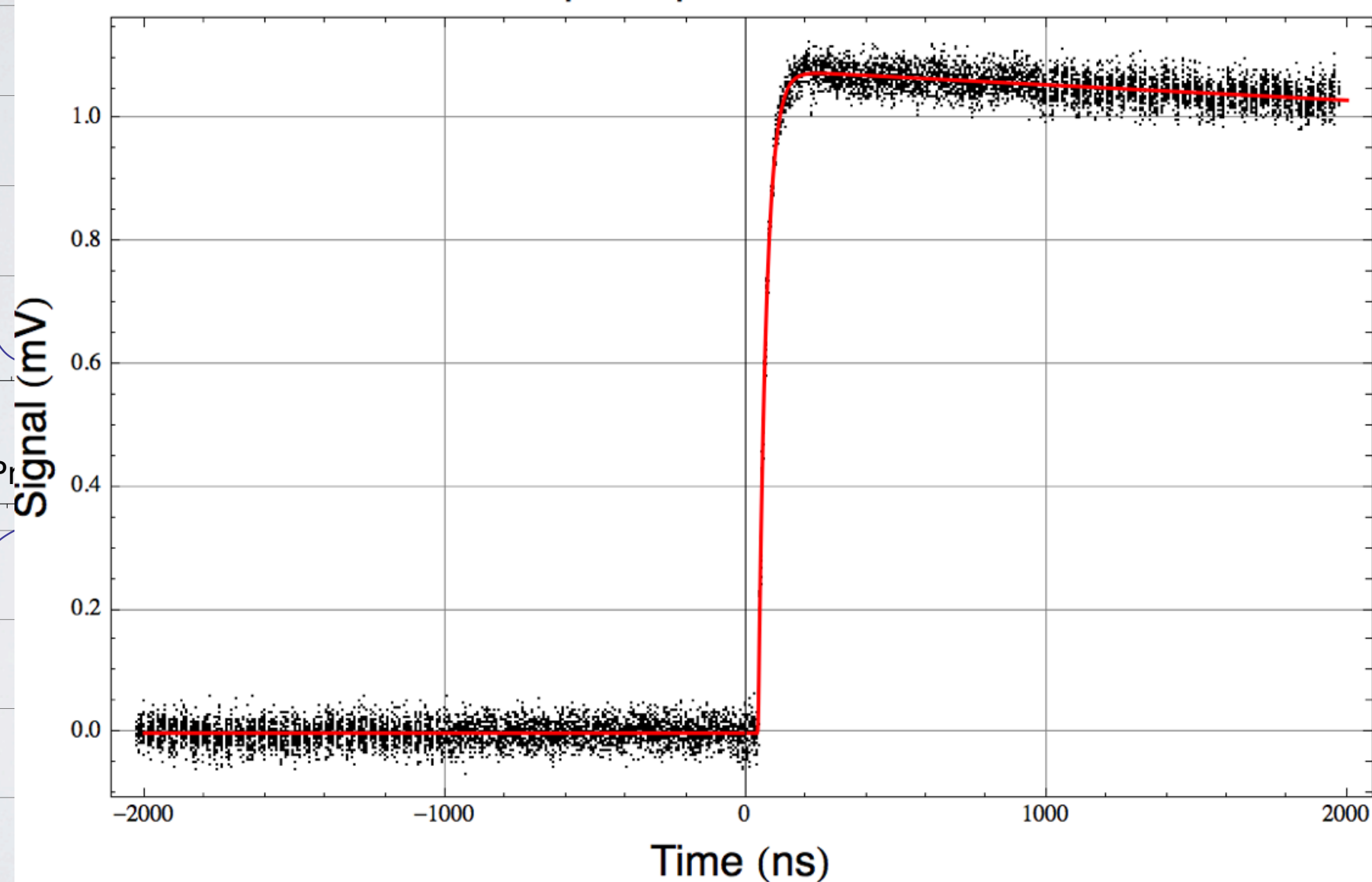
Preamp Impulse Response



Preamp Step Response



Preamp Response to the Pulser



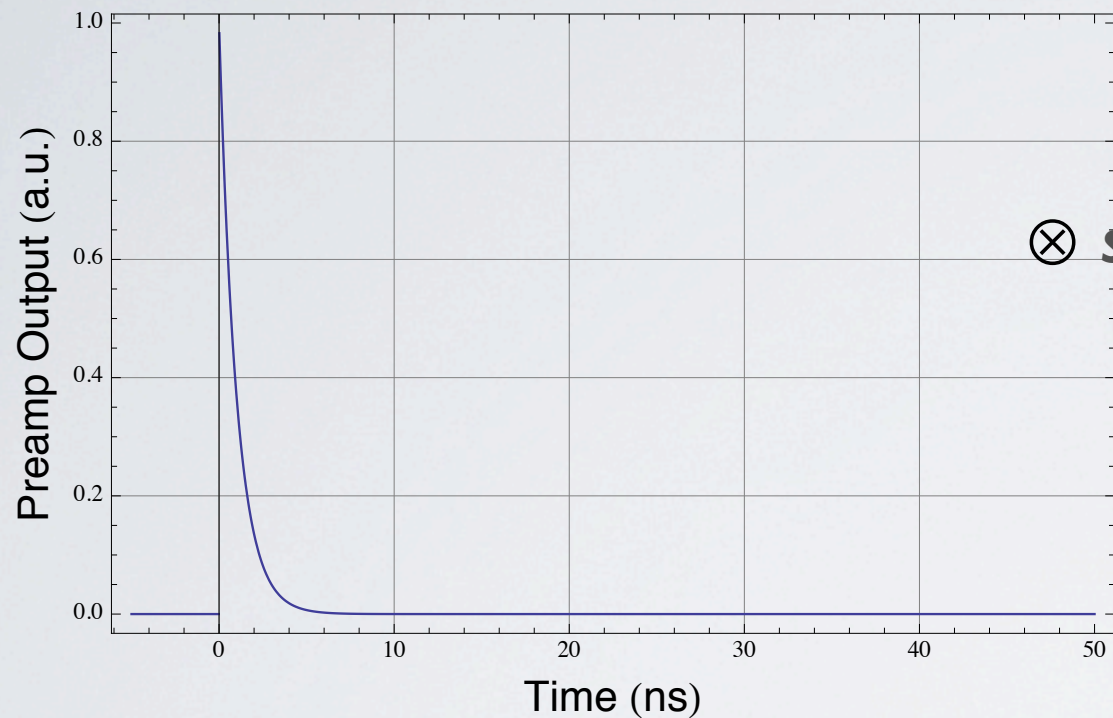
ng and Gaussian Avg.



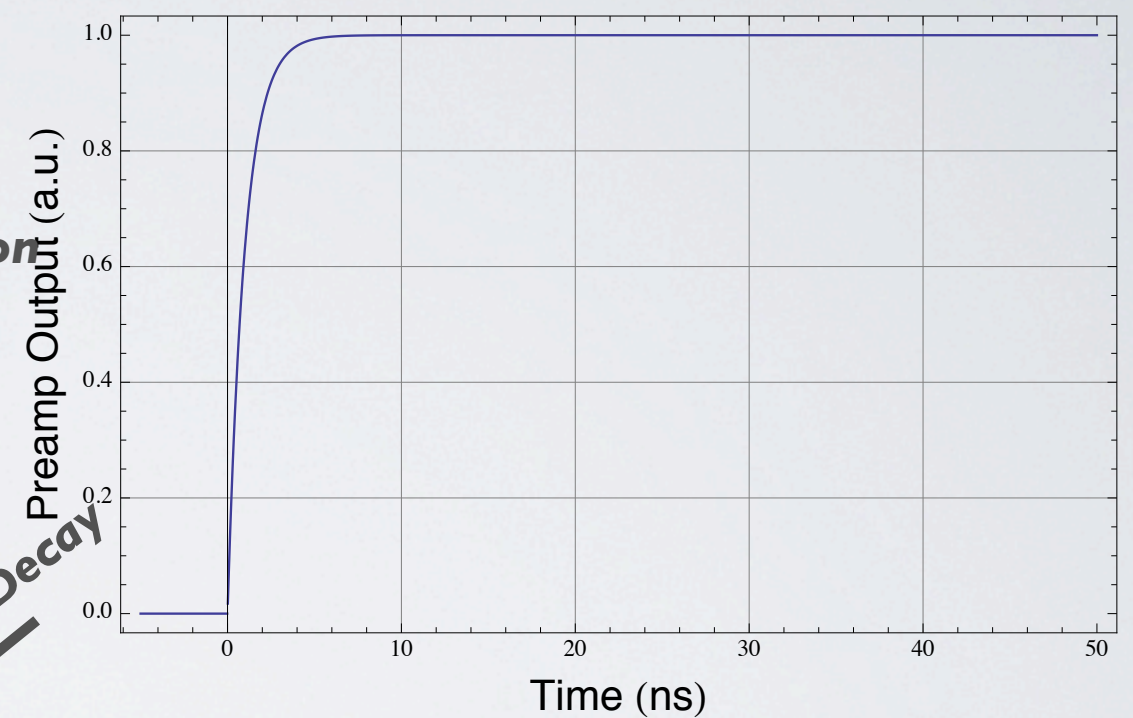
System Modeling: Preamplifier Modeling

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2. The model agrees with the preamp response to the pulser input data.

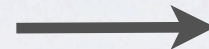
Preamplifier Impulse Response



Preamplifier Step Response

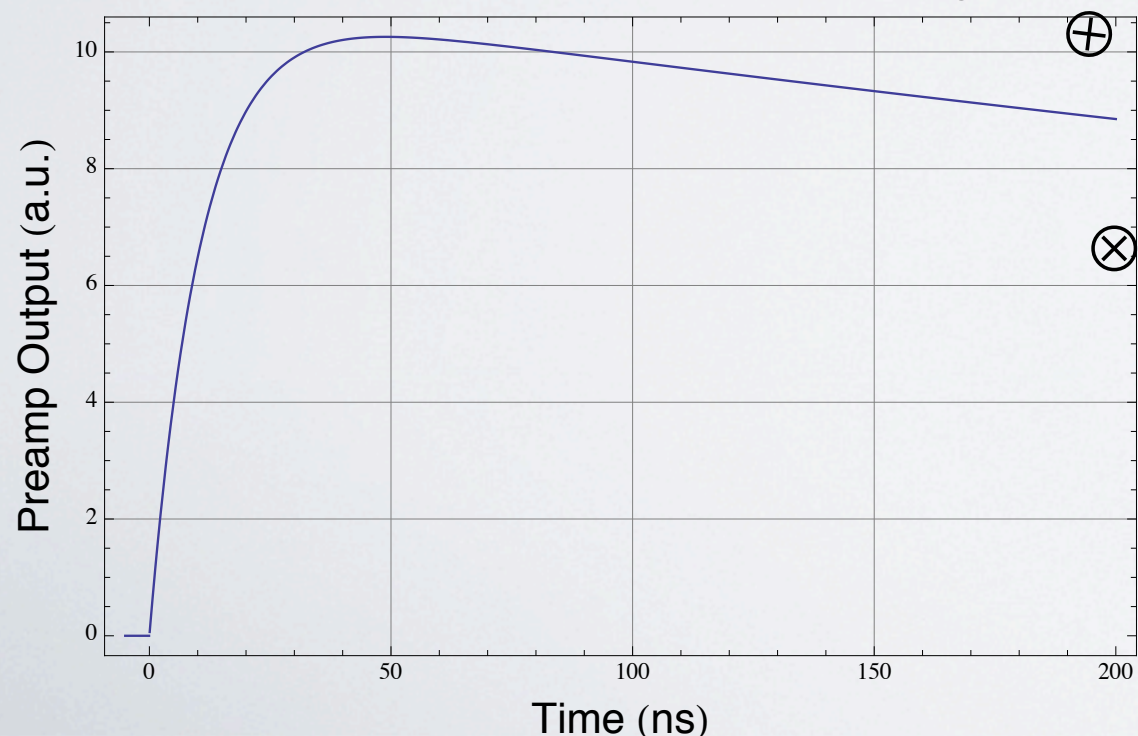


\otimes **Step function**

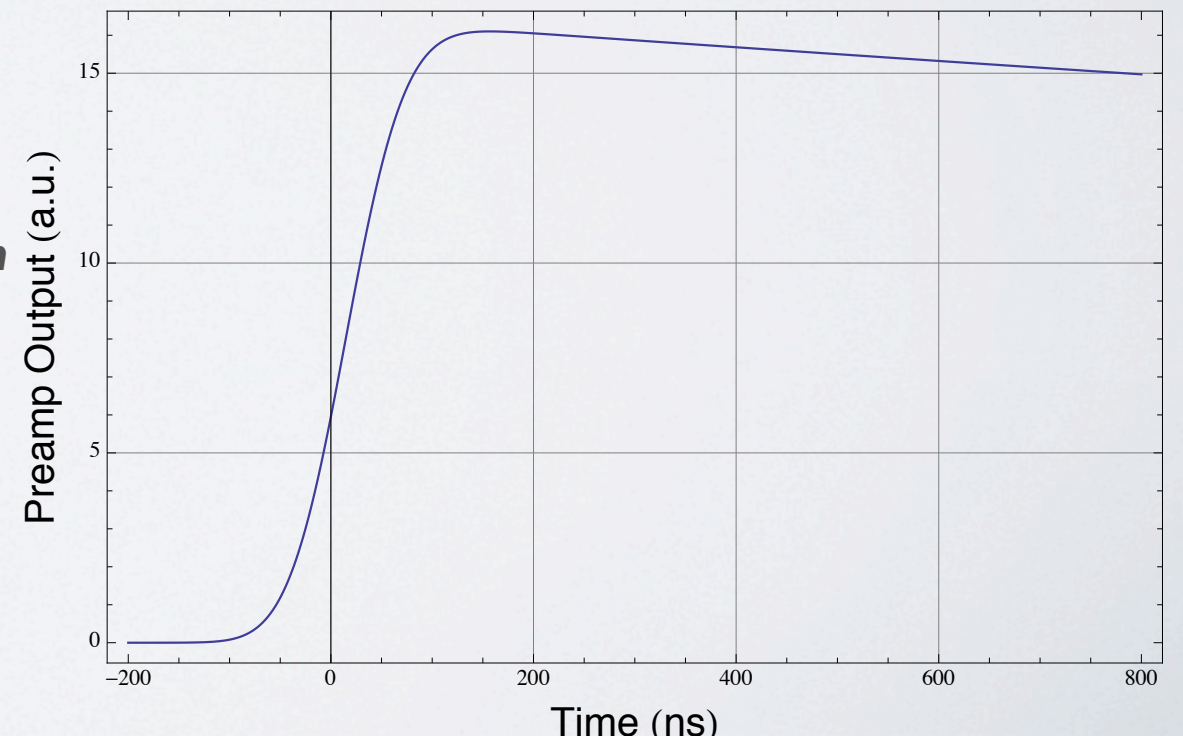


Exponential Decay

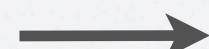
Preamplifier Step Response with damping



Preamplifier Step Response with damping and Gaussian Avg.



\otimes **Gaussian**



System Modeling: Shaping Amplifier Modeling

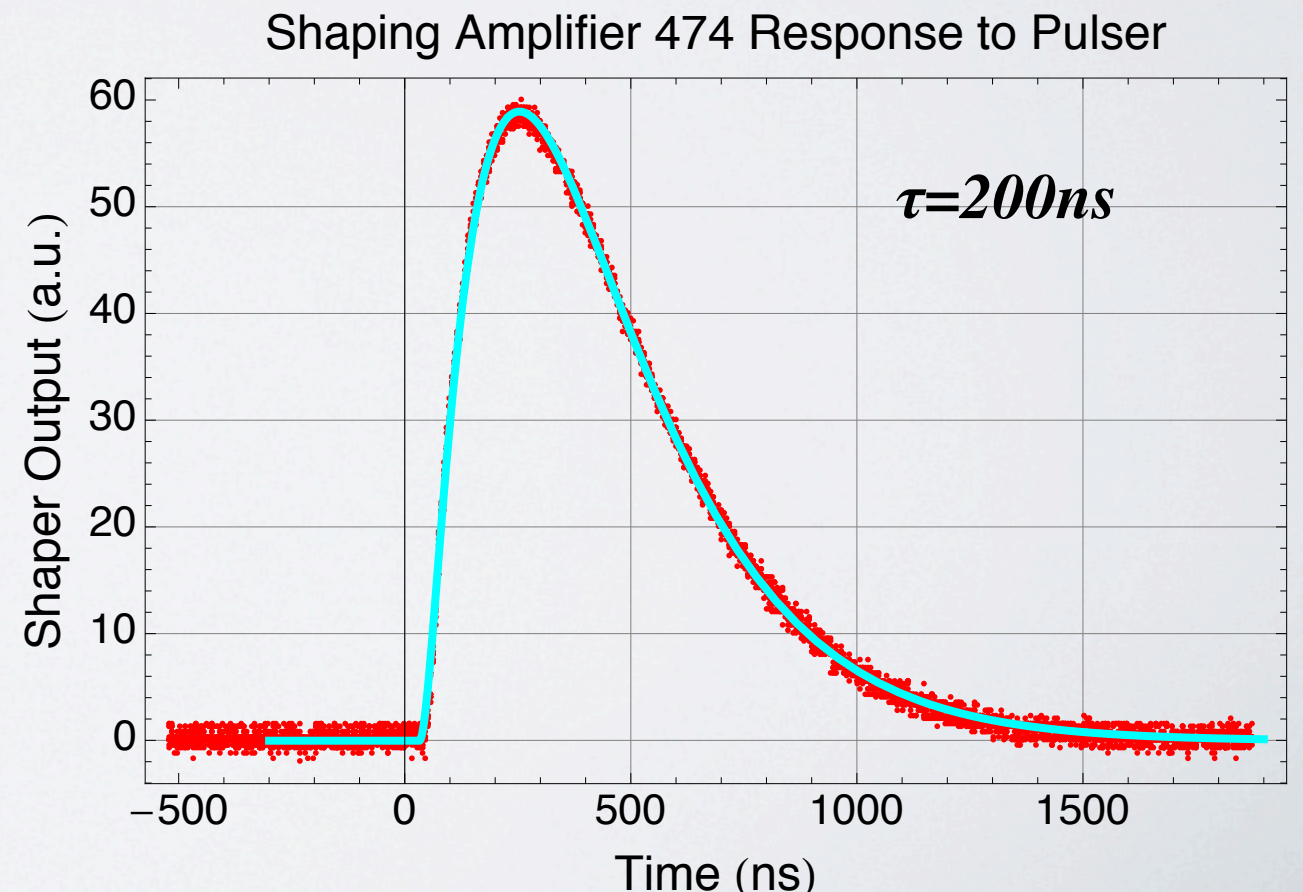
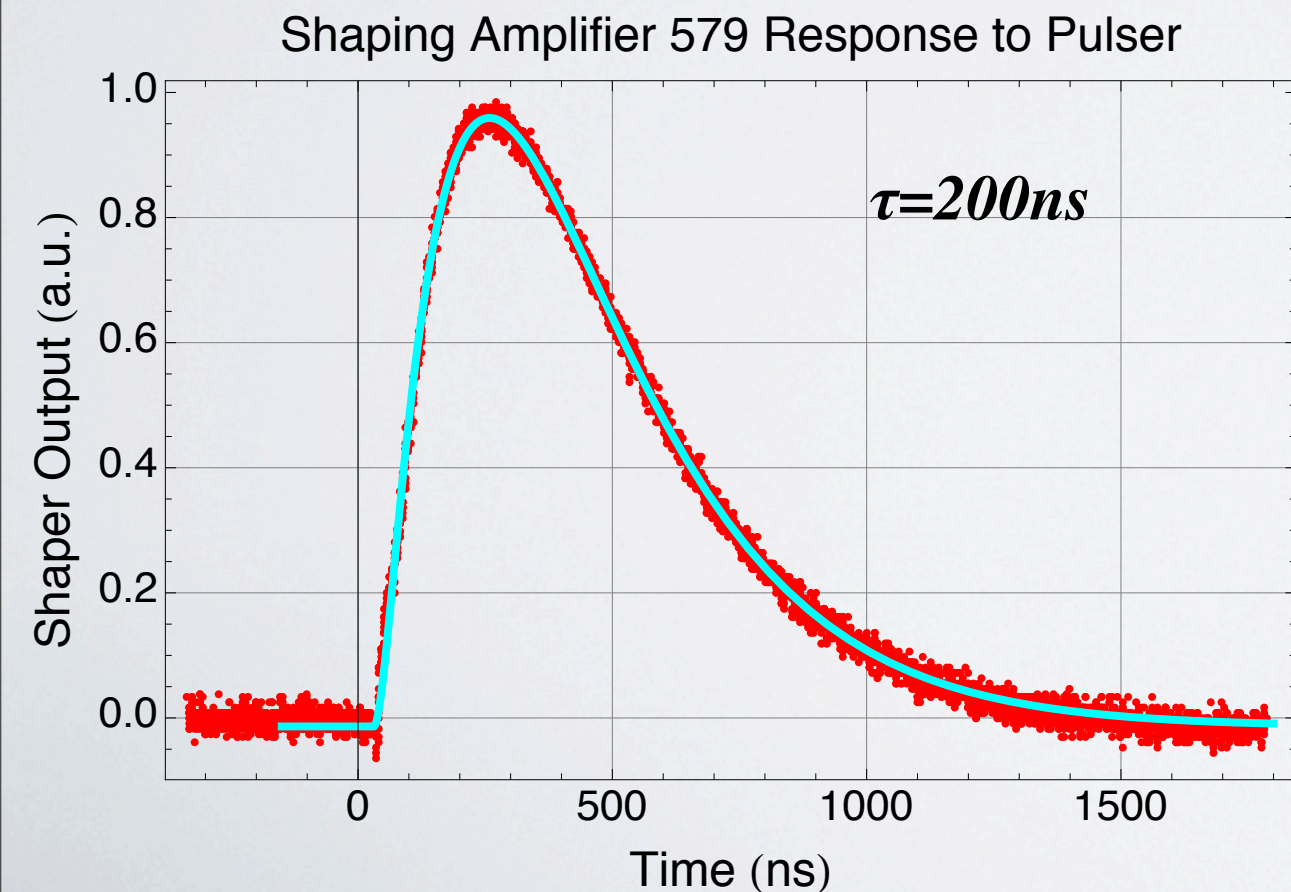
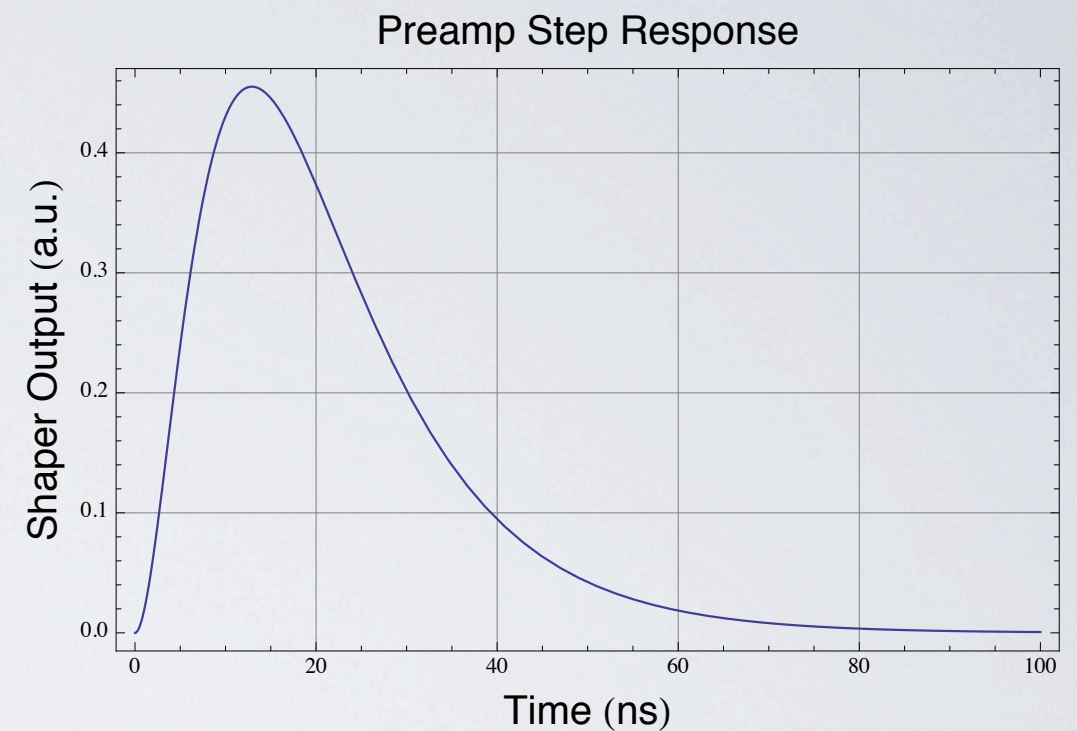
1. The shaping amplifier is simulated as a CR-RCⁿ filter with a transfer function as

$$H(s) = \left(\frac{s\tau}{1 + s\tau} \right) \left(\frac{1}{1 + s\tau} \right)^n$$

Its impulse response is $L^{-1}\{H(s)\}$

Step response is $H(t) = \int_0^t L^{-1}\{H(s)\} dt$

2. The pulser signal is applied into two different shaping amplifiers and the model with single stage CR-RC shaping agrees with the data.



System Modeling: Fit to the data

1.The whole system can be described as:

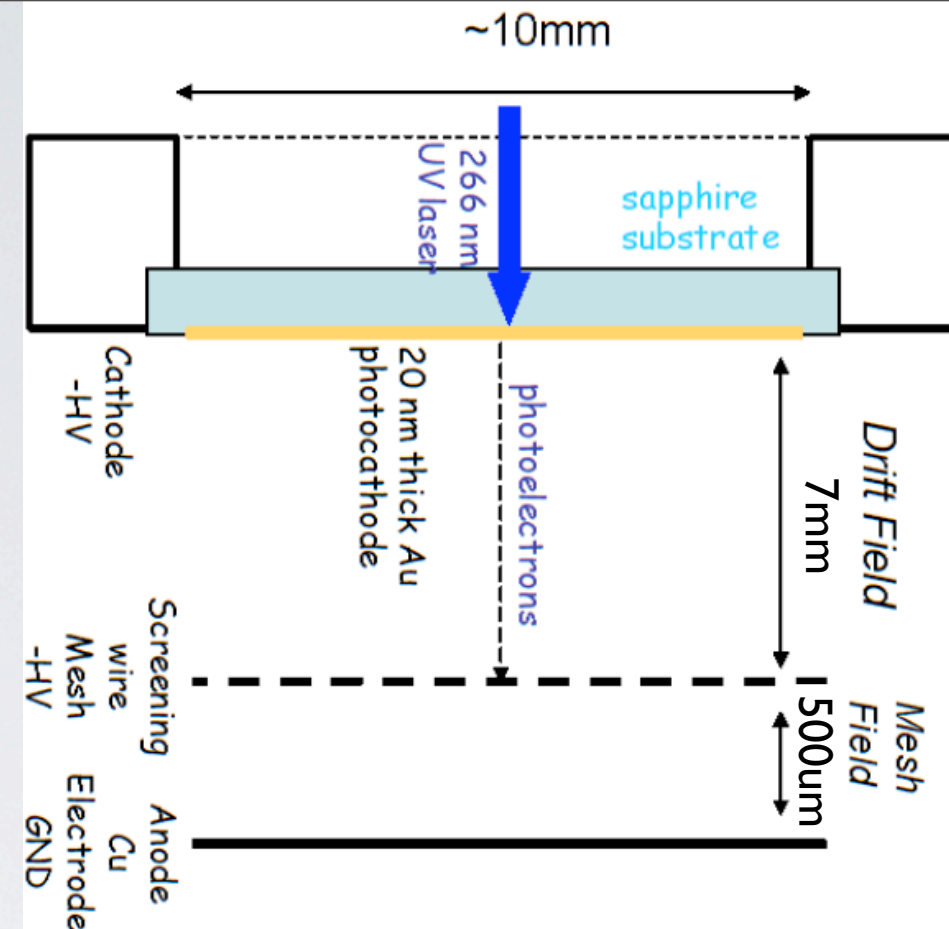
$$V_{out}(t) = V_{electron}(t) \otimes H_{preamp}(t) \otimes H_{shaper}(t)$$

the existing data taken in LAr with 512 frame averaging is fitted with the system model.

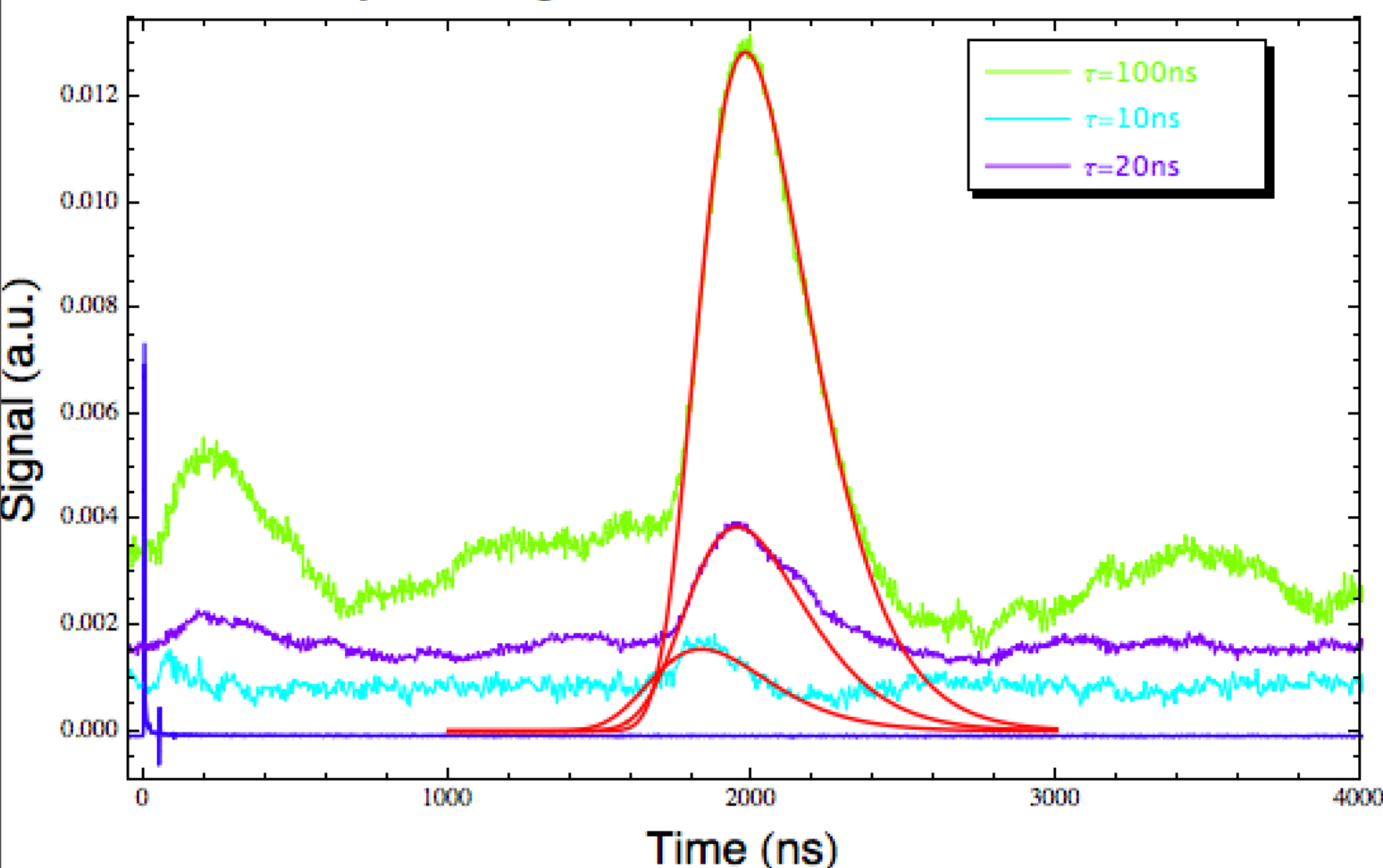
2.The exponential decay of the preamp response is ignored.

3. Noise has not be considered.

4. Need to improve SNR.



System Signal for 7 mm Drift @ 2.9kV/cm



Shaping time(ns)	σ_D (ns)	$D(\text{cm}^2/\text{s})$
10	17.0	5.6
20	28.4	15.6
100	21.9	9.2

The rise time contribution by the Longitudinal diffusion is:

$$\tau_{rise} = 2.5631 \sigma_D$$

$$\sigma = \sqrt{\frac{2Dz}{V}}$$

*the electron drift velocity in LAr under 2.9kV/cm is 3mm/us.

Summary

- The model developed for the simulation and data analysis agree with the data.
- The noise will be added into the model in the future development .
- Need to improve SNR.